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(54) PORTABLE DENTAL INSTRUMENT

(71) We, MITSUBISHI DENKI KABUSHIKI KAISHA, of No. 12, Marunouchi 2-chome, Chiyoda-ku, Tokyo, Japan, a Body Corporate organized and existing under the Law of Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a portable self-contained dental instrument by means of which a dentist may cut cavities in decayed teeth or effect machining and/or polishing of dentures.

Heretofore it has been commonly practised to drive such a dental instrument by transmitting power from an associated electric motor through an endless belt to its hand piece. Alternatively, compressed air from an air compressor is fed to a rotary vane wheel disposed within such a hand piece through a length of flexible hose to transmit the required power to the hand piece. The dental instrument is separated from its source of power and the source is an electric motor or an air compressor. This makes the equipment large in size. Further the use of an endless belt and the associated belt arm or of a length of flexible hose as a power transmission mechanism causes not only a loss of power but also a reduction in the working region for the dentist, so that any dentist who is required to perform delicate treatment inevitably has to adopt an unnatural posture. This, together with any mechanical vibration of the belt or hose, transmitted to his hand, causes him to become greatly fatigued.

The invention provides a portable instrument comprising an elongated hand piece, a contra-angle member mounted at one end of

said hand piece and including a rotary shaft and an interchangeable tool, a miniature electric motor of the DC type disposed within said hand piece, an electrical storage battery disposed within said hand piece to energise said motor which is arranged to drive the tool through said rotary shaft, said hand piece being provided at the other end with a socket for use in charging said storage battery from an external source of direct current, the storage battery and said motor being substantially aligned with the axis of said rotary shaft.

The hand piece may conveniently have a normally open pushbutton switch disposed on the reduced portion thereof. Only during manual depression of the pushbutton is the motor energized.

In order to prevent the motor from rotating at a speed above a predetermined magnitude, a governor mechanism may be provided integral with the motor.

The invention will be further described in conjunction with the accompanying drawings in which:

Figure 1 is a diagrammatic front elevational view of a dental instrument constructed in accordance with the invention;

Figure 2 is an enlarged longitudinal sectional view, partly in elevation, of the instrument illustrated in Figure 1;

Figure 3 is a sectional view taken along the line III-III of Figure 2;

Figure 4 is a fragmental exploded perspective view of a contra-angle member and the adjacent end portion of a hand piece of the instrument illustrated in Figures 1 and 2;

Figure 5 is a perspective view of a coupling of the instrument illustrated in Figure 2;

Figure 6 is a schematic diagram of an electric circuit which may be used with the invention; and

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Figure 7 is a schematic diagram of a charging circuit adapted to be used to charge a storage battery disposed within the present instrument.

5 The instrument shown comprises a grip or hand piece 10 including a main body 12 of any suitable plastics material in the form of a hollow cylinder, a tip member 14 of any suitable plastics material in the form of a truncated hollow cone having an enlarged end portion screw threaded at 16 into the adjacent end portion of the main body 12, and a bottom cover 18 of any suitable plastics material screw threaded at 20 into the other end portion of the main body 12 to close the latter.

10 Disposed in the interior of the main body 12 and on that side near the tip member 14 is a miniature electric motor 22 of DC type including a rotary shaft 24 extending toward the tip member 14 and having disposed adjacent that side thereof remote from the tip member 14 a governor mechanism 26 directly coupled to the rotary shaft 24. The governor mechanism 26 serves to prevent the speed of rotation of the motor 22 from increasing above a predetermined magnitude. A closed cylindrical storage battery or accumulator 28 is disposed within the main grip body 12 and on that side of the governor mechanism 26 remote from the motor 22 with a spacer 30 of any suitable plastics material interposed. In order to connect the motor 22 to the battery 28 the spacer 30 is provided with an electrical contact 32 electrically connected to the positive pole of the battery 28 and connected to the positive terminal of the motor 22 through a lead 34. The motor 22 is held in place within the main body 12 of the hand piece 10 by a locking screw 36 screw threaded into the wall of the main body 12.

15 As best shown in Figure 2, the tip member 14 carries at its reduced end a contra-angle member 38 of well known construction. The contra-angle member 38 has a retaining shaft 40 integral therewith and extending within the tip member 14 to be firmly and adjustably secured to the latter, and a thin rotary shaft 42 rotatably fitted into the retaining shaft 40 and supported by a suitable bearing 44 such as an oil impregnated bearing. The rotary shaft 42 is provided on the free end portion with a cross pin 46 projecting bilaterally thereof and it is aligned with the motor shaft 24. The contra-angle member 38 also includes a conventional operating lever 48 serving to engage and disengage the retaining shaft 40 with and from an interchangeable drill bit or burr 50 or the like removably mounted at the exposed end.

20 The longitudinal axes of the motor 22 and battery 28 are substantially aligned with the axis of the rotary shaft 42 and the hand piece 10 containing the abovementioned components is formed substantially into an

elongated shape to be easily gripped by the fingers of a dentist.

The cover 18 is provided on the outside with a cylindrical recess where a socket assembly 52 is attached for the purpose of charging the battery 28 from any suitable external source of direct current. The receptacle assembly 52 includes a contact pin 54 adapted to be electrically connected to a negative terminal of an external charging device, a cup-shaped contact sheet 55, a washer 56 of any suitable electrically insulating material for electrically insulating the pin 54 from the cup 55, and a U-shaped contact strip 58 connecting the pin 54 to the negative pole of the battery 28.

The hand piece 10 is provided on the enlarged end portion of the tip member 14 with a normally open pushbutton switch 60.

25 As shown in Figure 3, the switch 60 comprises a movable contact strip 61 in the form of a segment fixed at one end on the internal wall surface of the enlarged end portion of the tip member 14 e.g. by a rivet, and a stationary contact strip 62 suitably fixed on the same wall surface with the free end portions of the contact strips opposed to and slightly spaced from each other. A relatively short rod or a button 63 of any suitable plastics material loosely extends through that portion of the tip wall substantially diametrically to the fixed end of the movable contact strip 61 until it reaches the adjacent portion of the strip 61 where the button is rigidly secured. The button 63 projects somewhat beyond the external wall of the tip member 14 and can be manually pushed to engage the movable contact strip 61 with the stationary contact strip 62 or to close the switch 60.

30 As shown in Figure 6, the switch 60 is connected in a series circuit including the battery 28, the motor 22 and contacts controlled by the governor mechanism 26 and connected across a capacitor 79. The capacitor 79 serves to protect the governor contacts from arcing and also to prevent radio interference. The switch 60 can be closed to complete the circuit with the motor 22 only when the button 63 is pressed.

35 As best shown in Figure 4, the tip member 14 is provided on the reduced end face with a plurality of, in this example four, axial notches of the same shape 64, 65, 66 and 67 disposed at substantially equal angular intervals and the retaining angle shaft 40 is provided on that end contiguous to the main body of the contra-angle member 38 with a single protrusion 68 complementary in shape to the notches and adapted to selectively engage one of the notches 64 to 67. As shown in Figure 2, the retaining shaft 40 has rigidly secured on the other end portion a ring 70. Disposed between the ring 70 and the inside of the reduced tip end is a compression spring

72 tending to pull the contra-angle member 38 against the end of the tip member 14 so as to prevent the protrusion 68 from disengaging from the particular notch engaged by it.

In order to couple the motor shaft 24 to the rotary shaft 42 a cylindrical coupling 74 (Figure 5) of any suitable plastics material has the motor shaft 24 rigidly secured to one end portion and a central hole 76 axially drilled in the other end portion which is provided with a pair of diametrical slots 78 greater in axial or longitudinal length than the protrusion 68 on the retaining shaft 40. The rotary shaft 42 is inserted into the central hole 76 while the cross pin 46 is fitted into the diametric slots 78 whereby the motor 22 and rotary shaft 42 are substantially aligned with each other and in power transmission relationship.

In operation a dentist can grip the dental instrument by having the main grip body 12 placed on the root portions of his right thumb and index finger while the tip member 14 is gripped by the said fingers and the associated middle finger. Then he puts the contra-angle member 38 into a mouth of a patient such that the burr 50 approaches a decayed tooth, for example on the lower jaw, after which the dentist pushes the switch button 63 by his thumb or index finger to close the switch 60 and energise the motor 22. The motor 22 transmits torque through the coupling 74 and the rotary shaft 42 to the burr 50 which rotates to cut the decayed tooth.

The loading on the burr 50 depends upon the caries of the particular decayed tooth. If the loading decreases to cause a tendency for the motor 22 to increase its speed of rotation above a predetermined magnitude, the governor mechanism 26 operates to disconnect the motor 22 from the battery 28, thus ensuring that the motor 22 is prevented from excessive speed. As the motor slows down, the governor mechanism ceases to disconnect the motor 22 from the battery 28 and the motor 22 is again energized by the battery 28.

The process as above described is repeated unless the switch button 63 is released. Upon releasing the switch button 63, the motor 22 stops.

If a decayed tooth in the upper jaw is desired to be cut, then the contra-angle member 38 is manually pulled up against the action of the spring 72 to disengage the protrusion 68 on the retaining shaft 40 from the notch 64 previously engaged by the protrusion. Then the contra-angle member 38 is manually rotated with respect to the hand piece 10 about the axis of rotation of the same until the protrusion 68 engages the notch 66 opposite the notch 64 so that the contra-angle member 38 assumes its position illustrated in dot-and-dash line in Figure

1, where the contra-angle² 38 is tilted in a direction reversed from its previous direction. The switch button 63 remains in the same orientation as before. This permits the switch button 63 to be similarly operated by the right thumb or index finger of the dentist.

Also, depending upon the surface to be cut of a decayed tooth, the protrusion 68 may engage either of the remaining notches 65 and 67 to orient the contra-angle member 36 in such a direction that a dentist can easily use the instrument, with no change in orientation of the switch button 63.

After the instrument has been repeatedly used, the energy stored in the storage battery 28 decreases to a lower limit at which the battery must be recharged. Under these circumstances, the socket 52 disposed on the bottom cover 18 can be electrically connected to a pair of output terminals of any suitable charging device such as that generally designated by the reference numeral 80 in Figure 7. The charging device 80 comprises a pair of input terminals 81 and 82 adapted to be connected to any suitable source of commercial alternating current, and a step-down transformer 84 having a primary winding connected across the input terminals 81 and 84 through a switch 86. The secondary winding of the transformer 84 is connected across a pair of AC input terminals of a rectifier bridge 88 comprising four semiconductor diodes. The bridge 88 has a pair of DC output terminals 89 and 90.

With the output terminals 89 and 90 connected to the contact pin and contact cup 54 and 55 of the socket 52 respectively, the battery 28 can be fully charged by the charging device 80 energized by an external source of alternating current through the now closed switch 86. Then the socket 52 can be disengaged from the output terminals 89 and 90 of the device 80 whereupon it is ready for further operation.

The invention has several advantages. For example, it eliminates the necessity of providing a large dental electric motor or air compressor and the associated components which have been previously required, to drive a drill bit or burr, by the provision of a miniature DC motor, a storage battery for driving the motor and a mechanism for transmitting the torque of the motor to the burr, i.e. means for driving the burr, accommodated within the associated hand piece with a contra-angle member mounted at one end of the hand piece. Thus the present dental instrument is small, inexpensive and simple in construction. Also the elimination of an endless belt and the associated arm or a length of flexible hose permits the working region within which a dentist can perform treatment to increase while he can assume an easy posture suitable for cutting the particular decayed tooth of a patient. This

results in a great decrease in fatigue as compared with the conventional apparatus using an endless belt or a length of flexible hose.

5 Since the motor, the battery and the contra-angle member have their longitudinal axes substantially aligned with each other while the hand piece accommodating these components is in an elongated form, the hand
10 piece can be placed on the root portions of the right thumb and index finger of a dentist, leading to easy operation of the instrument. Simultaneously the torque of the motor is
15 directly transmitted to the burr through the shaft on the contra-angle member substantially aligned with the motor shaft resulting in a decrease in loss of power.

20 Since the storage battery is used as a source of electric power and the socket is disposed on the hand piece for the purpose of charging the battery, the battery can be fully charged at night and thereby in the daytime the
25 instrument is used in the treatment room whenever treatment is required. A dentist carrying the present instrument can make a call on a patient at his house. The battery can be charged without being removed from the associated hand piece.

30 As previously described, the switch for controlling the operation of the motor is disposed on the enlarged end portion of the tip member and the motor is energized only when the switch is manually put in closed
35 position. The switch can be opened and closed by fingering while the contra-angle member is held in a mouth of a patient. Therefore the present instrument can be extremely conveniently operated as compared
40 with the conventional apparatus including a foot switch adapted to be closed after the associated contra-angle has been placed into a mouth of a patient. The release of the switch button ensures the prevention of
45 any danger that might occur in a mouth of a patient. Thus the present instrument can be operated with a high degree of safety.

50 The provision of the governor mechanism preventing the motor from rotating at excessively high speed permits the torque of the motor to be transmitted to the contra-angle at substantially constant speed
55 of the motor even if the load on the burr varies. Further the amount of tooth material to be cut can be maintained substantially constant whereby any patient is prevented from suffering pain due to excessive cutting.

60 As previously described, the notches 64 to 67 inclusive on the tip member 14 co-operates with protrusion 68 on the contra-angle member 38 to provide means for fixing the
65 contra-angle member to the hand piece 10 in any selected one of several predetermined orientations relative to the latter. Therefore, if a different decayed tooth is desired to be cut it is required only to vary the orientation

of the contra-angle member while the orientation of the switch button 63 remains unchanged. Accordingly, a dentist using the present instrument can push the switch
70 button 63 under a stable pressure by his accustomed finger.

75 It will be seen that, if the contra-angle member is rotated relative to the hand piece to vary its orientation, the axis of the rotary shaft 42 may, due to possible errors in manufacturing, be somewhat laterally offset
80 from the axis of the motor shaft 24. In this event the torque of the motor will still be effectively transmitted to the angle shaft without hindrance by means of the cross pin 46 on the shaft 42 engaging the slots 78 on the coupling 74.

WHAT WE CLAIM IS:—

1. A portable dental instrument comprising an elongated hand piece, a contra-angle
85 member mounted at one end of said hand piece and including a rotary shaft and an interchangeable tool, a miniature electric motor of the DC type disposed within
90 said hand piece, an electrical storage battery disposed within said hand piece to energise said motor which is arranged to drive the tool through said rotary shaft, said hand piece
95 being provided at the other end with a socket for use in charging said storage battery from an external source of direct current, the storage battery and said motor being
100 substantially aligned with the axis of said rotary shaft.

2. A portable dental instrument as claimed in claim 1, comprising a normally open
105 push-button switch disposed on a reduced portion of said hand piece, said motor being energised only when said switch is manually pushed.

3. A portable dental instrument as claimed in claim 1 or 2, comprising a governor
110 mechanism integral with said motor to maintain the rotation of said motor at not more than a predetermined speed.

4. A portable dental instrument as claimed in any of claims 1 to 3, comprising means for
115 selectively fixing said contra-angle member to said hand piece in one of a plurality of predetermined orientations obtained by the rotation of the contra-angle member relative to said hand piece.

5. A portable dental instrument as claimed in any of claims 1 to 4, wherein
120 said rotary shaft on said contra-angle member is provided on a free end portion with a cross pin projecting bilaterally and said motor includes a driving shaft rigidly connected to one
125 end of a coupling, said coupling having formed in its other end an axial central hole into which said rotary shaft is inserted and also a pair of diametrical slots engaging said cross pin.

6. A portable dental instrument substantially as herein described with reference to the accompanying drawings.

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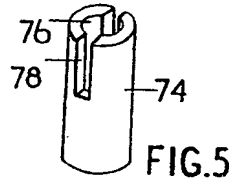
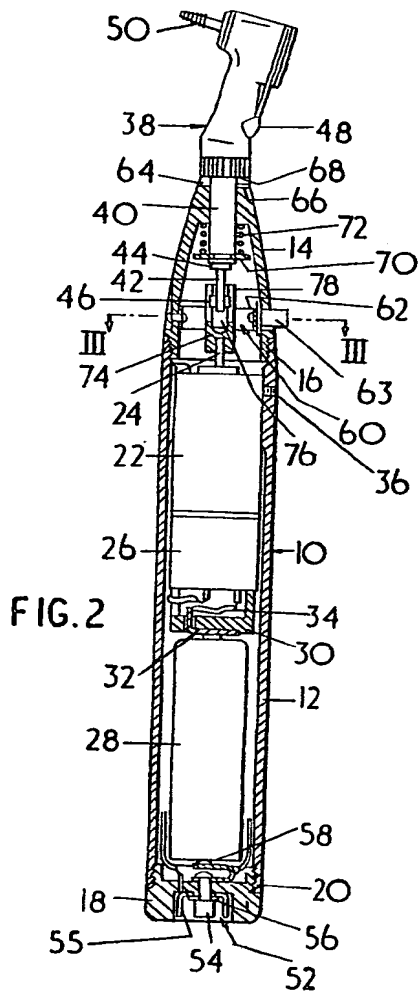
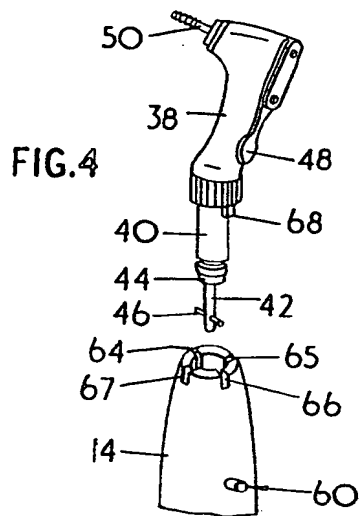
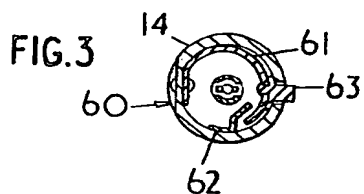
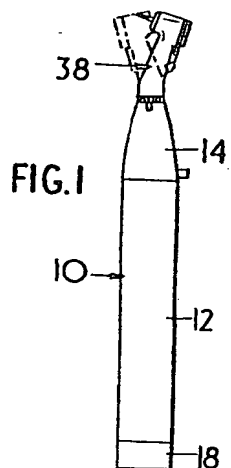


FIG.6

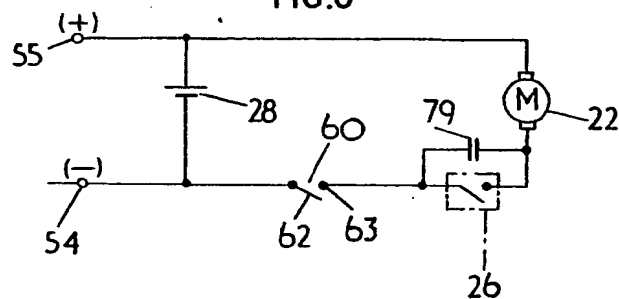


FIG.7

